COMBINATION HAMMER AND ROTARY DRILL TOOL

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FIG. 2
My invention relates to new and useful improvements in combination hammer and rotary drill tools, particularly adapted for the drilling of relatively hard rock formations.

Conventional rotary drilling tools, lubricated by high pressure drilling mud from the surface, normally have relatively high cutting rates but suffer from the principal disadvantage of a central core being formed due to the fact that the inner cutting teeth travel at a lower speed than the outer cutting teeth.

By providing a reciprocating chisel ended hammer centrally located within the radial cutting tool, I eliminate this central core and at the same time prebreak or fracture the central portion of the rock being drilled thus speeding up the drilling and making the drilling operation more efficient.

The principal object and essence of my invention is therefore to provide a device of the character herein described in which a reciprocating chisel ended ram or hammer fractures the central area of the rock being drilled thus facilitating the action of the rotary drill.

Another object of my invention is to provide a device of the character herein described which utilizes a high pressure drilling mud for the actuation of the reciprocating hammer ram.

Yet another object of my invention is to provide a device of the character herein described which is self contained and can readily be secured between the lower end of the drill string and the drill bit.

Still another object of my invention is to provide a device of the character herein described which is automatic in action and does not require external actuation outside of the source of power provided by the high pressure drilling mud passing downwardly through the drill string.

Yet another object of my invention is to provide a device of the character herein described which is simple in construction, economical in manufacture, and otherwise well suited to the purpose for which it is designed.

With the foregoing objects in view, and such other objects and advantages as will become apparent to those skilled in the art to which this invention relates as this specification proceeds, my invention consists essentially in the arrangement and construction of parts all as hereinafter more particularly described, reference being had to the accompanying drawings in which:

FIGURE 1 is a longitudinal sectional view of the upper end of my device.
FIGURE 2 is a partial longitudinal section of the next portion of my device, being a continuation from the lower end of FIGURE 1.
FIGURE 3 is a vertical section of the lowermost portion of my device, being a continuation from the lower end of FIGURE 2.

In the drawings like characters of reference indicate corresponding parts in the different figures.

Proceeding therefore to describe my invention in detail, reference should be made to the accompanying drawings in which reference character 10 illustrates a conventional cylindrical adaptor normally secured to the lower end of a conventional drill string (not illustrated).

The lower end 11 of this adaptor joint is externally screw threaded and adapted to receive the internally screw threaded upper end 12 of an outer cylindrical casing 13 which encloses the entire operating portion of my invention.

The lower end 14 of the casing (FIG. 2) is also internally screw threaded and adapted to receive an adaptor cylinder 15, to the lower end 16 of which is secured screw threadedly, a modified conventional rotary bit assembly collectively designated 17 (FIG. 3). This rotary bit assembly is modified to the extent that it may receive a cylindrical ram shaft 18 centrally therein, said ram having a chisel end 19 at the lower end thereof and an enlarged ram head 20 at the upper end thereof.

A relatively weak spring 21 surrounds the upper portion of the ram stem and reacts between the head 20 and the upper end 22 of the rotary bit assembly thus normally maintaining the ram in the uppermost position. In this connection it should be observed that FIG. 3 shows the ram in the lowermost or struck position.

Channels 23 are formed between the ram stem 18 and the central passageway 24 of the rotary drill to permit the conventional high pressure drilling mud to pass to the lower end for lubricating purposes in the conventional manner.

An annular shoulder 25 (FIG. 2) is formed internally adjacent the lower end 14 of the casing 13 and a hammer shaft packing gland nut 26 registers against this annular shoulder due to the circumferential flange 27 formed on this nut.

A cylindrical sliding valve cylinder sleeve 28 is screw threadably secured to this nut and extends upwardly through the casing in annular spaced relationship therefrom.

A further annular shoulder 29 (FIG. 1) is formed internally of the casing adjacent the upper edge thereof and a circumferential flange 30, formed on the upper closed end 31 of the sleeve 28, registers within this shoulder 29 as shown.

A spacer ring 32 surrounds the inner wall of the casing just above the shoulder and is clamped into position by means of the cylinder sleeve retaining nut which is screw threadably engageable within the upper end of the casing as clearly shown in FIG. 1. This mounts the sleeve 28 in the desired annular spaced relationship with the casing thus forming a cylindrical annular channel 33 which permits passage of the high pressure drilling mud entering through the centrally located bore 34 from the adaptor joint 10. In this connection the circumferential flange 30 is provided with a plurality of apertures 35 to permit passage of the drilling mud and also the circumferential flange 27 at the lower end of the casing, is also provided with a plurality of apertures 36 for a similar purpose.

Sliding valve cylinder 37 is adapted to reciprocate within the sleeve 28, the limits of the reciprocal movement of this cylindrical valve are defined, insofar as the lower end is concerned, by the aforementioned packing gland nut 26 against which the lower end 38 of the cylinder registers, and, insofar as the upper limit is concerned, by an internal annular shoulder 39 formed within the sleeve 28 adjacent the upper end thereof, against which the upper end 40 of the valve registers.

An annular, hard rubber bumper block 41 is secured to the lower end 38 of the valve by means of screw threadably engageable ring 42 and snap ring 43.

A similar hard rubber ring 44 is secured by bonding to a rotor nut 45 screw threadably engageable with the upper end 40 of the valve cylinder.

It is desirable that the sliding valve cylinder does not rotate during reciprocation otherwise misalignment of the various ports would occur. A spacer ring 46 (FIG. 1) is fixedly surrounding the valve cylinder 37, said spacer ring being provided with a pair of closed ended vertical slots.
47. Screw threaded plugs 48 extend through the casing adjacent this ring and engage the valve sleeve 28. A spring loaded ball 49 is held within the plugs 48 and engages the slots 47 and the wall of the sleeve 28 thus permitting reciprocation of the valve cylinder but preventing rotation thereof.

An annular seal 50 surrounds the valve just above the spacer ring 46, said seal engaging a shoulder 51 formed on the valve cylinder.

An annular spacer 52 is situated the other side of sleeve 28 and seal 53 is provided immediately below this spacer ring.

Various other seals 54 and spacer rings 55 surround the valve cylinder and are held in place by the screw threaded ring 42 at the lower end thereof which has been previously described.

A cylindrical hammer shaft collectively designated 56 is journaled for limited reciprocation within the valve cylinder 37, a bearing ring 57 and seals 58 being provided within the aforementioned packing gland nut 26 (FIG. 2) and being held in position by means of caps 59 secured to the nut by means of the studs 60.

The annular area 72 of the drill mud and the hammer shaft is annularly flared as at 62 and includes piston means 63 secured to the upper end by means of nut 64. A piston sealing ring 65 surrounds the piston together with a packing gland 66 and this piston also supports the upper end 61 of the hammer shaft.

A heavy duty compression spring 67 reacts between the piston upper end 68 and the underside 69 of the aforementioned closed upper end 31 of the cylinder sleeve, annular recess 70 being provided within this upper end to receive the end of the spring.

This spring 67 normally maintains the hammer shaft in the downward or lowermost position as shown in FIGURES 1 and 2.

Inlet port means collectively designated 71 are provided between the annular drilling mud channel 33 and the annular area 72 formed between the hammer shaft and the valve cylinder 37 but the inlet porting is only complete when the valve cylinder is in the lowermost position as shown in FIGURE 1, under which circumstances the ports 73 through the walls of the valve cylinder 37 coincide with the ports 74 formed through the wall of the cylinder sleeve 28.

Reference to FIGURE 2 will show exhaust port means 75 consisting of a ported plug 76 screw threadably engaged through an aperture within the wall of the casing 10, the internal body 77 of the plug passing through the mud drilling chamber 33 and into the wall of the valve cylinder sleeve 28.

An exhaust port 78 is formed through the wall of the valve cylinder but, when in the position shown in FIGURES 1 and 2, this exhaust port is below the air exhaust port 75 so that exhausting externally of the casing is prevented.

Coming back to FIGURE 1, and situated just below the upper end of the valve cylinder is a tapered annular chamber 79 formed around the external surface, this chamber terminating with the aforementioned shoulder 51 against which seal 50 registers.

An inlet port 80 communicates between the drill mud annular chamber 33 through the wall of the valve sleeve 28, and when the valve cylinder is raised slightly, communicates with the tapered annular chamber 79, the purpose of which will hereinafter be explained.

In operation, high pressure drilling mud passes downwardly through the adapter joint 10, through the bore 34 and around and through the annular chamber 33, through the channels 23 within the rotary drill bit and to the drill bit faces.

With the hammer shaft 56 and the valve cylinder 37 being in the lowermost position, high pressure drilling mud enters through the inlet ports 71 and reacts between the lower end of the cylindrical valve (packing gland nut 27), and the underside of the annular flange 62 of the hammer shaft and the piston ring 65 thus moving the piston and hammer shaft upwardly against pressure of spring 67, it being understood at this point that the valve cylinder does not reciprocate.

When the hardened rubber ring 66 upon the other side of the piston reaches an internal annular shoulder 81 formed adjacent the upper end of the valve cylinder 37, the valve cylinder is moved upwardly thus closing off the inlet porting 71 and 72. However, at this time the aforementioned porting 70 unseals the tapered recess 79 thus communicating high pressure drilling oil to the valve cylinder which, due to the tapered configuration of this recess, continues the upward movement of the valve cylinder, the hammer shaft being held against the compression of spring 67 by fluid locking.

Continued slight movement of the valve cylinder upwardly, then aligns the exhaust port 78 within the cylinder to the exhaust port 75 externally of the casing thus releasing the fluid block and permitting the spring 67 to force the hammer shaft downwardly so that the lower end 82 of the hammer shaft strikes the recessed upper end 83 of the valve cylinder thus moving it downwardly against the pressure of the light spring 21.

A collar 84 surrounding the hammer shaft spaced from the lower end 82 thereof strikes a stop ring 85 screw threadably engageable within the lower end 83 of the valve cylinder thus returning the valve cylinder to its original position whereinupon the sequence is repeated. In this connection a hardened rubber or fibre ring 86 is interposed between the flange 84 and the ring 85 to absorb the shock of this return action.

Due to the use of high pressure drilling mud, the entire sequence is very rapid and repetitive thus causing a continual hammering action of the ram end 19 against the rock formation being drilled by the rotary drill bit.

Since various modifications can be made in my invention as hereinabove described, and many apparently widely different embodiments of same made within the spirit and scope of the claims without departing from such spirit and scope, it is intended that all matter contained in the accompanying specification shall be interpreted as illustrative only and not in a limiting sense.

What I claim as my invention is:

1. A combination hammer and rotary drill tool which includes a cylindrical adaptor joint for connecting said tool to the conventional drill string and a source of high pressure drilling mud contained within said tool comprising in combination an outer cylindrical casing screw threadably attached to the upper end thereof to said adaptor joint, a rotary drill assembly screw threadably attached to the lower end of said casing, a sliding valve cylinder sleeve secured within said casing, in annular spaced relationship therewith forming a cylindrical annular drilling mud passage, a sliding valve cylinder mounted for limited reciprocal motion within said sleeve, a hammer shaft reciprocally within said sliding valve cylinder, piston means on said hammer shaft and engaging said cylinder, spring means reacting between said hammer shaft and the upper end of said sleeve normally maintaining said hammer shaft in the lowermost position, a ram centrally mounted within said rotary drilling assembly, a bit end on the lower end of said ram, the lower end of said hammer shaft striking the upper end of said ram when said hammer shaft is in the lowermost position, inlet port means through the wall of said sliding valve cylinder, porting means for raising said hammer, exhaust port means through the wall of said sliding valve cylinder for selectively porting said mud from the underside of said piston means to externally of said casing and means coaching between said hammer shaft and said valve cylinder for moving said valve cylinder from the lowermost, intake port connecting position to the uppermost exhaust port
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5 connecting position and further means coacting between said hammer shaft and said valve cylinder for moving said valve cylinder from the uppermost exhaust port connecting position to the lowermost, intake port connecting position.

2. The device according to claim 1 which includes further means coacting between said cylinder sleeve and said valve cylinder for maintaining said valve cylinder against rotary motion during reciprocation thereof.

3. The device according to claim 1 in which said inlet port means includes a port through the wall of said sleeve and a corresponding port through the wall of said valve cylinder, said exhaust port means including a port through the wall of said sleeve, and a corresponding port through the wall of said valve cylinder, said port through the wall of said sleeve being connected externally of said casing.

4. The device according to claim 1 in which said means coacting between said hammer shaft and said valve cylinder for moving said valve cylinder from the lowermost intake port connecting position to the uppermost exhaust port connecting position includes an internal annular shoulder adjacent the upper end of said valve cylinder engageable, on the up stroke, by the upper end of said hammer whereby said valve cylinder is raised.

5. The device according to claim 2 in which said means coacting between said hammer shaft and said valve cylinder for moving said valve cylinder from the lowermost intake port connecting position to the uppermost exhaust port connecting position includes an internal annular shoulder adjacent the upper end of said valve cylinder engageable, on the up stroke, by the upper end of said hammer whereby said valve cylinder is raised.

6. The device according to claim 3 in which said means coacting between said hammer shaft and said valve cylinder for moving said valve cylinder from the lowermost intake port connecting position to the uppermost exhaust port connecting position includes an internal annular shoulder adjacent the upper end of said valve cylinder engageable, on the up stroke, by the upper end of said hammer whereby said valve cylinder is raised.

7. The device according to claim 2 in which said means coacting between said cylinder sleeve and said valve cylinder comprises a vertically slotted spacer sleeve fixedly surrounding said sliding valve cylinder, and slidably engaging said valve cylinder sleeve, and at least one spring loaded ball engaging said slot and an aperture in said sleeve.

8. The device according to claim 3 in which said means coacting between said cylinder sleeve and said valve cylinder comprises a vertically slotted spacer sleeve fixedly surrounding said sliding valve cylinder, and slidably engaging said valve cylinder sleeve, and at least one spring loaded ball engaging said slot and an aperture in said sleeve.

9. The device according to claim 4 in which said means coacting between said cylinder sleeve and said valve cylinder comprises a vertically slotted spacer sleeve fixedly surrounding said sliding valve cylinder, and slidably engaging said valve cylinder sleeve, and at least one spring loaded ball engaging said slot and an aperture in said sleeve.

10. The device according to claim 5 in which said means coacting between said cylinder sleeve and said valve cylinder comprises a vertically slotted spacer sleeve fixedly surrounding said sliding valve cylinder, and slidably engaging said valve cylinder sleeve, and at least one spring loaded ball engaging said slot and an aperture in said sleeve.

11. The device according to claim 6 in which said means coacting between said cylinder sleeve and said valve cylinder comprises a vertically slotted spacer sleeve fixedly surrounding said sliding valve cylinder, and slidably engaging said valve cylinder sleeve, and at least one spring loaded ball engaging said slot and an aperture in said sleeve.

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